

DECLARATION OF DR. RANDELL L. MILLS

I, Randell L. Mills, declare and state as follows:

1. I am the founder and CEO of BlackLight Power, Inc., located at 493 Old Trenton Road, Cranbury, New Jersey 08512.
2. I majored in chemistry and received my bachelor of arts degree, *summa cum laude* and Phi Beta Kappa, from Franklin & Marshall College in 1982. I received a medical degree from Harvard Medical School in 1986. While attending Harvard Medical School, I concurrently spent a year taking courses in advanced electrical engineering at the Massachusetts Institute of Technology. I have also had significant academic training in biology, chemistry, mathematics and physics.
3. I began my research in the field of energy technology over ten years ago. I have authored, co-authored or collaborated on numerous publications, reports and presentations at scientific meetings in the field of energy technology and novel hydrogen chemistry, as shown in the attachment hereto.
4. I am fully qualified to conduct the research that led to the discovery and development of BlackLight's lower-energy hydrogen technology.
5. I personally conducted and/or supervised the experimental data disclosed in the articles submitted to the U.S. Patent and Trademark Office ("PTO"), which are described in the following Paragraph Nos. 6 through 27. The coauthors, if any, assisted me in preparing the data.
6. H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from an Incandescently Driven Plasma in a Potassium Carbonate Cell", *Plasma Sources Science and Technology*, submitted. Electromagnetic radiation in both the visible and vacuum ultraviolet (VUV) spectral ranges was emitted from an incandescently driven plasma in a potassium carbonate cell after the potassium carbonate coated on a titanium mesh was heated to

above 750°C in a hydrogen atmosphere. The pressure was between 0.1 and 1 mbar, and the hydrogen was dissociated by a hot tungsten wire. Bright visible light filled the annulus between the coaxial tungsten heater and the titanium mesh. This grid was at a floating potential. The emission of the H_α and H_β transitions as well as the L_α and L_β transitions were recorded and analyzed. In the latter spectral range, the spectra showed rotational-vibrational transitions of molecular hydrogen which belong to the Werner-band-system of molecular hydrogen. The plasma generated in the incandescently driven cell had phenomenological similarities to that of low pressure electrical driven discharges such as striations of the plasma or the appearance of unipolar arcs ending on metal surfaces. However, the plasma seemed to be far from thermal equilibrium and dependent on the chemistry of atomic hydrogen with potassium. Details of the chemistry powering a novel VUV-light source could not be revealed within the frame of this contribution.

7. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", Chem. Phys. Letts., submitted. Rb^+ to Rb^{2+} and $2K^+$ to $K + K^{2+}$ each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ to form a very stable novel hydride ion. Its predicted binding energy of 3.0468 eV was observed at 4070.0 Å with its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.0056 \times 10^{-5} + 3.0575$ eV (j is an integer) that matched for $j = 1$ to $j = 37$ to within a 1 part per 10^5 . This catalytic reaction may pump a cw HI laser.

8. R. L. Mills, B. Dhandapani, J. He, "Synthesis and Characterization of a Highly Stable Amorphous Silicon Hydride", Int. J. Hydrogen Energy, submitted. A novel highly stable surface coating $SiH(1/p)$ which comprised high binding energy hydride ions was synthesized by microwave plasma reaction of mixture of silane, hydrogen, and helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-

ray photoelectron spectroscopy. The ToF-SIMS identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. XPS identified the H content of the SiH coatings as hydride ions, $H^- (1/4)$, $H^- (1/9)$, and $H^- (1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively. The silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

9. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Characterization of Lithium Chloro Hydride", Int. J. Hydrogen Energy, submitted. A novel inorganic hydride compound lithium chloro hydride, $LiHCl$, which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy, 1H nuclear magnetic resonance spectroscopy, and powder X-ray diffraction. Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

10. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, submitted. Upon the addition of 5% argon to a hydrogen plasma, the Lyman α emission was observed to increase by about an order of magnitude; whereas, xenon control had no effect. With a microwave input power of 40 W, the gas temperature of an argon plasma increased from 400°C to over 750°C with the addition of 3% flowing hydrogen; whereas, the 400°C temperature of a xenon plasma run under identical conditions was essentially unchanged with the addition of hydrogen. The average hydrogen atom temperature of the argon-hydrogen plasma was measured to be 110 - 130 eV versus ≈ 3 eV for pure hydrogen or xenon-hydrogen. Stark broadening or acceleration of charged species due to high fields (e. g. over 10 kV/cm) can not be invoked to explain the results with argon since no high field was observationally present. The electron temperature T_e for the argon-hydrogen and xenon-hydrogen plasmas was $11,600 \pm 5\% K$ and $6500 \pm 5\% K$,

respectively, compared to $4800 \pm 5\% K$ and $4980 \pm 5\% K$ for argon and xenon alone, respectively. The observation of higher temperatures corresponding to three possibly independent plasma parameters for only argon with hydrogen may be explained by the release of energy from atomic hydrogen by a resonant nonradiative energy transfer mechanism.

11. R. L. Mills, P. Ray, " High Resolution Spectroscopic Observation of the Bound-Free Hyperfine Levels of a Novel Hydride Ion Corresponding to a Fractional Rydberg State of Atomic Hydrogen", Int. J. Hydrogen Energy, in press. From a solution of a Schrödinger-type wave equation with a nonradiative boundary condition based on Maxwell's equations, Mills solves the hydrogen atom, the hydride ion, and predicts corresponding species having fractional principal quantum numbers. Atomic hydrogen may undergo a catalytic reaction with certain atomized elements and ions which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, $m \cdot 27.2 \text{ eV}$ wherein m is an integer. The reaction involves a nonradiative energy transfer to form a hydrogen atom $H(1/p)$ that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number $(n = \frac{1}{p} = \frac{1}{\text{integer}})$ replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for

hydrogen excited states). The ionization of Rb^+ and an electron transfer between two K^+ ions (K^+ / K^+) provide a reaction with a net enthalpy of 27.2 eV which serve as catalysts of atomic hydrogen to form $H(1/2)$. Intense extreme ultraviolet (EUV) emission was observed from incandescently heated atomic hydrogen and each of atomized potassium and rubidium ions that generated a plasma called a resonance transfer or rt-plasma at low temperatures (e.g. $\approx 10^3 \text{ K}$) and an extraordinary low field strength of about $1-2 \text{ V/cm}$. For further characterization, the width of the 6562 \AA Balmer α line was recorded. Significant line broadening of 17 and 9 eV was observed from a rt-plasma of hydrogen with K^+ / K^+ and Rb^+ respectively. These results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm , corresponding to a broadening of much less than 1 eV . Rather the source of the excessive line broadening is consistent with that of the observed EUV emission, an energetic reaction caused by a resonance energy transfer between hydrogen atoms and K^+ / K^+ or Rb^+ . The catalyst

product $H(1/2)$ was predicted to be a highly reactive intermediate which further reacts to form a novel hydride ion $H^-(1/2)$. This hydride ion with a predicted binding energy of 3.0468 eV was observed by high resolution visible spectroscopy as a broad peak at 4070.0 \AA with a FWHM of 1.4 \AA . From the electron g factor, bound-free hyperfine structure lines of $H^-(1/2)$ were predicted with energies E_{HF} given by $E_{HF} = j^2 3.0056 \times 10^{-5} + 3.0575\text{ eV}$ (j is an integer) as an inverse Rydberg-type series that converges at increasing wavelengths and terminates at 3.0575 eV —the hydride spin-pairing energy plus the binding energy. The high resolution visible plasma emission spectra in the region of 4000 \AA to 4060 \AA matched the predicted emission lines for $j = 1$ to $j = 37$ to 1 part in 10^5 ,

12. R. L. Mills, E. Dayalan, "Novel Alkali and Alkaline Earth Hydrides for High Voltage and High Energy Density Batteries", Proceedings of the 17th Annual Battery Conference on Applications and Advances, California State University, Long Beach, CA, (January 15-18, 2002), in press. BLACKLIGHT POWER, Inc. (BLP) of Cranbury, New Jersey, is developing a revolutionary technology based on novel hydrogen chemistry. More explicitly, energy is catalytically released as the electrons of atomic hydrogen are induced to undergo transitions to lower energy levels corresponding to fractional quantum numbers with the production of plasma, light, and novel hydrogen compounds [1-35]. The Company uses a chemically generated or assisted plasma to form atomic hydrogen and a catalyst which react through a nonradiative energy transfer to form lower-energy hydrogen atoms called hydrinos. Since hydrinos have energy levels much lower than uncatalyzed hydrogen atoms, the energy release is intermediate between chemical and nuclear energies. The net enthalpy released may be over several hundred times that of combustion. Thus, the catalysis of atomic hydrogen represents a new source of energy with H_2O as the source of hydrogen fuel obtained by diverting a fraction of the output energy of the process to split water into its elemental constituents. Moreover, rather than air pollutants or radioactive waste, the products are novel compounds having hydride ions with increased binding energies that may be the basis of a high voltage battery. Such a high voltage battery would have the advantages of much greater power and much higher energy density where the limitations of battery chemistry attributed to the binding energy of the anion of the oxidant

are addressed. The concept of our novel hydride battery and some preliminary results will be discussed during the presentation.

13. R. Mayo, R. Mills, M. Nansteel, "On the Potential of Direct and MHD Conversion of Power from a Novel Plasma Source to Electricity for Microdistributed Power Applications", IEEE Transactions on Plasma Science, submitted. The generation of electricity using direct electrostatic and magnetohydrodynamic (MHD) conversion of the plasma particle energy of small to mid-size chemically assisted microwave or glow discharge plasmas (CA-plasma) power sources in the range of a few hundred Watts to several 10's of kW for microdistributed commercial applications (e.g. household, automotive, light industry, and space based power) is studied for the first time. In the determination of the effect of plasma parameters on conversion efficiency, careful attention is paid to the unique plasma conditions of low pressure, low ionization fraction, and nonthermal ion energies that are much greater than that of the thermal ions of traditional MHD but much lower than those of a fully ionized plasma typically generated for fusion experiments. The density of plasma ions and neutrals and their cross sections for processes such as charge exchange were also considered. The most important parameters were found to be charged particle density and energy, as well as the large inventory of neutral gas atoms and molecules. Momentum and charge exchange of plasma ions with the large background fraction of neutrals represents a limitation to conversion efficiency. Two conversion technologies were examined in some detail. We considered the possibility of converting a CA-plasma using adaptations of a member of the broad category of electromagnetic direct converters previously developed for recovery and conversion of the high energy particles lost from tandem mirror and magnetically confined plasmas, and an MHD converter previously developed for conversion of high pressure combustion gases to electricity. While it was found that both conversion techniques performed well under ideal conditions for conversion of plasma to electricity showing conversion efficiencies of ~70% are possible, the tight coupling of plasma cell and converter, size limitations, particle energy, and the substantial inventory of relatively low energy neutrals eliminate direct electrostatic converters as practical converters under these conditions. However, MHD conversion of CA-plasmas appears feasible at ~50% efficiency with a simple compact design.

14. R. Mills, P. Ray, J. Dong, M. Nansteel, W. Good, P. Jansson, B. Dhandapani, J. He, "Excessive Balmer α Line Broadening, Power Balance, and Novel Hydride Ion Product of Plasma Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", Int. J. Hydrogen Energy, submitted. Typically the emission of vacuum ultraviolet light from hydrogen gas is achieved using discharges at high voltage, synchrotron devices, high power inductively coupled plasma generators, or a plasma is created and heated to extreme temperatures by RF coupling (e.g. $> 10^6 K$) with confinement provided by a toroidal magnetic field. Observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g. $\approx 10^3 K$) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and certain gaseous atoms or ions vaporized by filament heating has been reported previously [R. Mills, J. Dong, Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", Int. J. Hydrogen Energy, Vol. 25, (2000), pp. 919-943]. Each of the ionization of potassium, cesium, strontium, and Rb^+ and an electron transfer between two K^+ ions (K^+ / K^+) provide a reaction with a net enthalpy of an integer multiple of the potential energy of atomic hydrogen. The presence of each of the corresponding reactants formed the low applied temperature, extremely low voltage plasma called a resonance transfer or rt-plasma having strong EUV emission. Similarly, the ionization energy of Ar^+ is 27.63 eV, and the emission intensity of the plasma generated by atomic strontium increased significantly with the introduction of argon gas only when Ar^+ emission was observed [R. Mills, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1041-1058.]. In contrast, the chemically similar atoms, sodium, magnesium and barium, do not ionize at integer multiples of the potential energy of atomic hydrogen did not form a plasma and caused no emission. For further characterization, we recorded the width of the 656.2 nm Balmer α line on light emitted from rt-plasmas. Significant line broadening of 17, 9, 11, 14, and 24 eV was observed from a rt-plasma of hydrogen with K^+ / K^+ , Rb^+ , cesium, strontium, and strontium with Ar^+ , respectively. These results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1 eV. Rather the

source of the excessive line broadening is consistent with that of the observed EUV emission, an energetic reaction caused by a resonance energy transfer between hydrogen atoms and K^+ / K^+ , Rb^+ , cesium, strontium, or Ar^+ . Since line broadening is a measure of temperature, the excess power was measured calorimetrically on rt-plasmas formed by K^+ / K^+ and Ar^+ as catalysts. The product hydride ion with each of K^+ / K^+ , Rb^+ , Cs , and Ar^+ as the catalyst was predicted to have a binding energy of 3.05 eV and was observed by high resolution visible spectroscopy at 407 nm.

15. R. Mills, E. Dayalan, P. Ray, B. Dhandapani, J. He, "Highly Stable Novel Inorganic Hydrides from Aqueous Electrolysis and Plasma Electrolysis", Japanese Journal of Applied Physics, submitted. Based on a solution of a Schrödinger-type wave equation with a nonradiative boundary condition from Maxwell's equations, atomic hydrogen is predicted to undergo a catalytic reaction with reactants which provide a net enthalpy of reaction of integer multiples of the potential energy of atomic hydrogen, 27.2 eV. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen with the release of energy. Each of the ionization of potassium, cesium, and Rb^+ and an electron transfer between two K^+ ions (K^+ / K^+) provide a reaction with a net enthalpy of an integer multiple of the potential energy of atomic hydrogen. For each of K^+ / K^+ , Rb^+ , and cesium, the net enthalpy of reaction of the catalyst is about 27.2 eV, and the lower-energy hydrogen atom catalysis product is predicted to be a highly reactive intermediate which further reacts to form a novel hydride ion $H^- (1/2)$. This ion formed by plasma electrolysis of a K_2CO_3 , Rb_2CO_3 , or Cs_2CO_3 electrolyte was observed by high resolution visible spectroscopy at 407.0 nm corresponding to its predicted binding energy of 3.05 eV. Whereas, no peak was observed during plasma electrolysis with the control Na_2CO_3 electrolyte. Furthermore, novel inorganic hydride compounds $KHKHCO_3$ and KH were isolated following the electrolysis of a K_2CO_3 electrolyte. The compounds which comprised high binding energy hydride ions were stable in water, and KH was stable at elevated temperature (600 °C). Inorganic hydride clusters $K[KHKHCO_3]^+$ were identified by positive ToF-SIMS of $KHKHCO_3$. The negative ToF-SIMS was dominated by hydride ion. The positive and negative ToF-SIMS of KH showed

essentially K^+ and H^- only, respectively. Moreover, the existence of novel hydride ions was determined using X-ray photoelectron spectroscopy, and proton nuclear magnetic resonance spectroscopy. Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

16. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer α Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", Chem. Phys., submitted. The width of the 656.2 nm Balmer α line emitted from microwave and glow discharge plasmas of hydrogen alone, strontium or magnesium with hydrogen, or helium, neon, argon, or xenon with 10% hydrogen was recorded with a high resolution visible spectrometer. It was found that the strontium-hydrogen microwave plasma showed a broadening similar to that observed in the glow discharge cell of 27 - 33 eV; whereas, in both sources, no broadening was observed for magnesium-hydrogen. With noble-gas hydrogen mixtures, the trend of broadening with the particular noble gas was the same for both sources, but the magnitude of broadening was dramatically different. The microwave helium-hydrogen and argon-hydrogen plasmas showed extraordinary broadening corresponding to an average hydrogen atom temperature of 110 - 130 eV and 180 - 210 eV, respectively. The corresponding results from the glow discharge plasmas were 30 - 35 eV and 33 - 38 eV, respectively. Whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen maintained in either source showed no excessive broadening corresponding to an average hydrogen atom temperature of ≈ 4 eV. In the case of the helium-hydrogen mixture and argon-hydrogen mixture microwave plasmas, the electron temperature T_e was measured from the ratio of the intensity of the He 501.6 nm line to that of the He 492.2 line and the ratio of the intensity of the Ar 104.8 nm line to that of the Ar 420.06 nm line, respectively. Similarly, the average electron temperature for helium-hydrogen and argon-hydrogen plasmas were high, 28,000 K and 11,600 K, respectively; whereas, the corresponding temperatures of helium and argon alone were only 6800 K and 4800 K, respectively. Stark broadening or acceleration of charged species due to high fields (e. g. over 10 kV/cm) can not be invoked to explain the microwave results since no high field was observationally present. Rather, the results may be explained by a resonant

energy transfer between atomic hydrogen and atomic strontium, Ar^+ , or He^+ which ionize at an integer multiple of the potential energy of atomic hydrogen.

17. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Spectroscopic Identification of Fractional Rydberg States of Atomic Hydrogen", J. of Phys. Chem. (letter), submitted. Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11, 12$ or these lines inelastically scattered by helium atoms wherein 21.2 eV was absorbed in the excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. These lines can be explained as fractional Rydberg states of atomic hydrogen. Novel emission lines were also observed at 44.2 nm and 40.5 nm with energies of $q \cdot 13.6 + \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \times 13.6\text{ eV}$ where $q = 2$ and $n_f = 2, 4$ $n_i = \infty$ that corresponded to multipole coupling to give two photon emission from a continuum excited state atom and an atom undergoing a fractional Rydberg state transition. Such transitions would be extremely energetic; so, the width of the 656.2 nm Balmer α line emitted from the plasmas was measured, and the electron temperature T_e was measured from the ratio of the intensity of the $He\text{ }501.6\text{ nm}$ line to that of the $He\text{ }492.2\text{ nm}$ line. Significant line broadening corresponding to an average hydrogen atom temperature of $180 - 210\text{ eV}$ was observed for helium-hydrogen microwave plasmas; whereas, pure hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of $\approx 3\text{ eV}$. Similarly, the average electron temperature for helium-hydrogen plasma was $28,000\text{ K}$; whereas, the corresponding temperature of helium alone was only 6800 K .

18. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Rydberg States of Atomic Hydrogen", Chem. Phys. Letts., submitted. Extreme ultraviolet spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$ or these lines inelastically scattered by helium atoms wherein 21.2 eV was absorbed in the excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. The average hydrogen atom temperature was $180 - 210\text{ eV}$ versus $\approx 3\text{ eV}$ for pure hydrogen. Similarly, T_e for helium-hydrogen was $28,000\text{ K}$.

compared to 6800 K for pure helium. With a microwave input power of 40 W, the thermal output power was measured to be at least 400 W corresponding to a power density of 40 MW/m^3 and an energy balance of at least $-5 \times 10^5 \text{ kJ/mole H}_2$ compared to the enthalpy of combustion of hydrogen of $-241.8 \text{ kJ/mole H}_2$.

19. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Rydberg States of Atomic Hydrogen that Surpasses Internal Combustion", Quantitative Spectroscopy and Energy Transfer, submitted. Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, \text{ or } 11$ or these lines inelastically scattered by helium atoms wherein 21.2 eV was absorbed in the excitation of $\text{He} (1s^2)$ to $\text{He} (1s^1 2p^1)$. These lines can be explained as fractional Rydberg states of atomic hydrogen. Such transitions would be extremely energetic; so, the width of the 656.2 nm Balmer α line emitted from the plasmas was measured, and the electron temperature T_e was measured from the ratio of the intensity of the He 501.6 nm line to that of the He 492.2 line. Significant line broadening corresponding to an average hydrogen atom temperature of 33 - 38 eV was observed for helium-hydrogen glow discharge plasmas; whereas, pure hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of $\approx 3 \text{ eV}$. Similarly, the average electron temperature for helium-hydrogen microwave plasmas was 28,000 K; whereas, the corresponding temperature of helium alone was only 6800 K. Since a significant increase in ion and electron temperature was observed with helium-hydrogen discharge and microwave plasmas, respectively, and energetic hydrino lines were observed at short wavelengths in the corresponding microwave plasmas that required a very significant reaction rate due to low photon detection efficiency in this region, the power balance was measured on the helium-hydrogen microwave plasmas. With a microwave input power of 40 W, the thermal output power was measured to be $238 \pm 8 \text{ W}$ corresponding to a reactor temperature rise from room temperature to 1240 °C within 60 seconds, a power density of 24 MW/m^3 , and an energy balance of at least $-3 \times 10^5 \text{ kJ/mole H}_2$ compared to the enthalpy of combustion of hydrogen of $-241.8 \text{ kJ/mole H}_2$.

20. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", Spectrochimica Acta, Part A, submitted. Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, \text{ or } 11$ or these lines inelastically scattered by helium atoms wherein 21.2 eV was absorbed in the excitation of $\text{He} (1s^2)$ to $\text{He} (1s^1 2p^1)$. These lines were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers. Significant line broadening corresponding to an average hydrogen atom temperature of $33 - 38 \text{ eV}$ was observed for helium-hydrogen discharge plasmas; whereas, pure hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of $\approx 3 \text{ eV}$. Since a significant increase in ion temperature was observed with helium-hydrogen discharge plasmas, and energetic hydrino lines were observed at short wavelengths in the corresponding microwave plasmas that required a very significant reaction rate due to low photon detection efficiency in this region, the power balance was measured on the helium-hydrogen microwave plasmas. With a microwave input power of 30 W , the thermal output power was measured to be at least 300 W corresponding to a reactor temperature rise from room temperature to $900 \text{ }^\circ\text{C}$ within 90 seconds, a power density of 30 MW/m^3 , and an energy balance of about $-4 \times 10^5 \text{ kJ/mole H}_2$ compared to the enthalpy of combustion of hydrogen of $-241.8 \text{ kJ/mole H}_2$.

21. R. L. Mills, P. Ray, "Spectroscopic Identification of a Novel Catalytic Reaction of Rubidium Ion with Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, in press. From a solution of a Schrödinger-type wave equation with a nonradiative boundary condition based on Maxwell's equations, Mills predicts that atomic hydrogen may undergo a catalytic reaction with certain atomized elements and ions which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, 27.2 eV . The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen with the release of energy. One such atomic catalytic system involves Rb^+ from RbNO_3 . Since the second ionization energy of rubidium is 27.28 eV , the reaction Rb^+ to

Rb^{2+} has a net enthalpy of reaction of 27.28 eV. Intense extreme ultraviolet (EUV) emission was observed from incandescently heated atomic hydrogen and the atomized Rb^+ catalyst that generated an anomalous plasma at low temperatures (e.g. $\approx 10^3 K$) and an extraordinary low field strength of about 1-2 V/cm. No emission was observed with Rb^+ or hydrogen alone or when $NaNO_3$ replaced $RbNO_3$ with hydrogen. Emission was observed from Rb^{2+} that confirmed the resonant nonradiative energy transfer of 27.2 eV from atomic hydrogen to atomic Rb^+ . The catalysis product, a lower-energy hydrogen atom, was predicted to be a highly reactive intermediate which further reacts to form a novel hydride ion. The predicted hydride ion of hydrogen catalysis by Rb^+ is the hydride ion $H^- (1/2)$. This ion was observed spectroscopically at 407 nm corresponding to its predicted binding energy of 3.05 eV.

22. R. Mills, J. Dong, W. Good, P. Ray, J. He, B. Dhandapani, "Measurement of Energy Balances of Noble Gas-Hydrogen Discharge Plasmas Using Calvet Calorimetry", Int. J. Hydrogen Energy, in press. From a solution of a Schrödinger-type wave equation with a nonradiative boundary condition based on Maxwell's equations, Mills predicts that atomic hydrogen may undergo a catalytic reaction with certain gaseous ions such as Ar^+ which ionize at integer multiples of the potential energy of atomic hydrogen, 27.2 eV. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen with the release of energy. Upon the addition of 5% argon catalyst to a hydrogen plasma, the Lyman α emission was observed to increase by about an order of magnitude which indicated an increase in the plasma temperature; whereas, krypton control had no effect. Thus, the energy balances of argon-hydrogen glow discharge plasmas were measured using Calvet calorimetry. The steady state Calvet voltage significantly increased upon the addition of 3% hydrogen, and the output signal was integrated until the signal returned to baseline. An energy balance of over $-151,000 \text{ kJ/mole } H_2$ was measured compared to the enthalpy of combustion of hydrogen of $-241.8 \text{ kJ/mole } H_2$. Whereas, under identical conditions no change in the Calvet voltage was observed when hydrogen was added to a plasma of krypton which does not provide a reaction with a net enthalpy of a multiple of the potential energy of atomic hydrogen under these conditions.

23. R. L. Mills, A. Voigt, P. Ray, M. Nansteel, B. Dhandapani, "Measurement of Hydrogen Balmer α Line Broadening and Thermal Power Balances of Noble Gas-Hydrogen Discharge Plasmas", Int. J. Hydrogen Energy, in press. Line broadening of the hydrogen Balmer lines provides a sensitive measure of the number and energy of excited hydrogen atoms in a glow discharge plasma. The width of the 656.5 nm Balmer α line emitted from gas discharge plasmas having atomized hydrogen from pure hydrogen alone, hydrogen with magnesium or strontium, a mixture of 10% hydrogen and helium, argon, krypton, or xenon, and a mixture of 10% hydrogen and helium or argon with strontium was measured with a high resolution ($\pm 0.025 \text{ nm}$) visible spectrometer. It was found that strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen plasmas showed significant broadening corresponding to an average hydrogen atom temperature of 25 - 45 eV; whereas, pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of $\approx 3 \text{ eV}$. Since line broadening is a measure of the plasma temperature, and a significant difference was observed between these noble gases, the power balances of gas discharge plasmas having atomized hydrogen from 1.) pure krypton alone, 2.) a mixture of hydrogen with argon or krypton and 3.) a mixture of hydrogen and helium or argon with vaporized strontium were measured. The power emitted for power supplied to the glow discharge increased by 35-83 W depending on the presence of helium or argon and less than 1% partial pressure of strontium metal in noble gas-hydrogen mixtures. Whereas, the chemically similar noble gas krypton alone or with hydrogen had no effect on the power balance. Catalyst atoms or ions which ionize at integer multiples of the potential energy of atomic hydrogen (Sr , He^+ , or Ar^+) caused an increase in power; whereas, no excess power was observed in the case of krypton which does not provide a reaction with a net enthalpy of a multiple of the potential energy of atomic hydrogen under these conditions. For a power input to the glow discharge of 110 W, the excess output power of mixtures of strontium with argon-hydrogen (95/5%), strontium with hydrogen, strontium with helium-hydrogen (95/5%), and argon-hydrogen (95/5%) was 75, 58, 50, and 28 W, respectively, based a comparison of the temperature rise of the cell with krypton-hydrogen mixture (95/5%) and krypton alone. The input power was varied to find conditions that resulted in the optimal output for the strontium-hydrogen plasma. At 136 W input, the excess power

significantly increased to 184 W. These studies provide a useful comparison of catalysts for the optimization of the catalytic reaction of atomic hydrogen which represents an important new power source.

24. R. Mills, P. Ray, "Vibrational Spectral Emission of Fractional-Principal-Quantum-Energy-Level Hydrogen Molecular Ion", Int. J. Hydrogen Energy, in press. From a solution of a Schrödinger-type wave equation with a nonradiative boundary condition based on Maxwell's equations, Mills solves the hydrogen atom, the hydrogen molecular ion, the hydrogen molecule and predicts corresponding species having fractional principal quantum numbers. Atomic hydrogen may undergo a catalytic reaction with certain atomized elements and ions which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, $m \cdot 27.2 \text{ eV}$ wherein m is an integer. The reaction involves a nonradiative energy transfer to form a hydrogen atom $H(1/p)$ that is lower in energy than unreacted atomic hydrogen that corresponds

to a fractional principal quantum number ($n = \frac{1}{p} = \frac{1}{\text{integer}}$) replaces the well known parameter

$n = \text{integer}$ in the Rydberg equation for hydrogen excited states). One such atomic catalytic system involves argon ions. The reaction Ar^+ to Ar^{2+} has a net enthalpy of reaction of 27.63 eV , which is equivalent to $m = 1$. Thus, it may serve as a catalyst to form $H(1/2)$. Also, the second ionization energy of helium is 54.4 eV ; thus, the ionization reaction of He^+ to He^{2+} has a net enthalpy of reaction of 54.4 eV which is equivalent to $2 \cdot 27.2 \text{ eV}$. The products of the catalysis reaction $H(1/3)$ may further serve as catalysts to form $H(1/4)$ and $H(1/2)$. $H(1/p)$ may react with a proton to form an excited state molecular ion $H_2^*(1/p)^+$ that has a bond energy and vibrational levels that are p^2 times those of the molecular ion comprising uncatalyzed atomic hydrogen where p is an integer. Thus, the excited state spectrum of $H_2^*[n = 1/4; n^* = 2]^+$ was predicted to comprise rotationally broadened vibrational transitions at 1.185 eV increments to the dissociation limit of $H_2[n = 1/4]^+$, $E_D = 42.88 \text{ eV}$ (28.92 nm). Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of argon or helium with 10% hydrogen in the range $10 - 65 \text{ nm}$. Novel emission lines assigned to vibrational transitions of $H_2^*[n = 1/4; n^* = 2]^+$ were observed in this range with energies of $\nu \cdot 1.185 \text{ eV}$, $\nu = 17 \text{ to } 38$ that terminated at 28.9 nm . In addition, fractional molecular hydrogen rotational transitions were

assigned to previously unidentified lines in the Solar coronal spectrum that matched theoretical predictions to five figures.

25. R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, Vol. 27, No. 3, (2002), pp. 301-322. From a solution of a Schrödinger-type wave equation with a nonradiative boundary condition based on Maxwell's equations, Mills predicts that atomic hydrogen may undergo a catalytic reaction with certain atomized elements and ions which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, $m \cdot 27.2 \text{ eV}$ wherein m is an integer. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number ($n = \frac{1}{p} = \frac{1}{\text{integer}}$ replaces the well known

parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states). One such atomic catalytic system involves helium ions. The second ionization energy of helium is 54.4 eV ; thus, the ionization reaction of He^+ to He^{2+} has a net enthalpy of reaction of 54.4 eV which is equivalent to $2 \cdot 27.2 \text{ eV}$. Since the products of the catalysis reaction have binding energies of $m \cdot 27.2 \text{ eV}$, they may further serve as catalysts. Extreme ultraviolet (EUV) spectroscopy was recorded on microwave and glow discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, \text{ or } 11$ or these lines inelastically scattered by helium atoms wherein 21.2 eV was absorbed in the excitation of $\text{He}(1s^2)$ to $\text{He}(1s^1 2p^1)$. These lines were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers. Furthermore, astrophysical data was reviewed and such transitions were found to match the spectral lines of the extreme ultraviolet background of interstellar space. They may resolve the paradox of the identity of dark matter and account for many celestial observations such as: diffuse H α emission is ubiquitous throughout the Galaxy and widespread sources of flux shortward of 912 \AA are required. Fractional hydrogen transitions were also assigned to unidentified lines in the Solar EUV spectrum which may resolve the solar neutrino problem, the mystery of the cause of sunspots and other solar activity, and why the Sun emits X-rays.

26. R. Mills, P. Ray, "Spectroscopic Identification of a Novel Catalytic Reaction of Potassium and Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, Vol. 27, No. 2, February, (2002), pp. 183-192. From a solution of a Schrödinger-type wave equation with a nonradiative boundary condition based on Maxwell's equations, Mills predicts that atomic hydrogen may undergo a catalytic reaction with certain atomized elements and ions which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen, 27.2 eV , $m \cdot 27.28\text{ eV}$ wherein m is an integer. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen with the release of energy. One such atomic catalytic system involves potassium atoms. The first, second, and third ionization energies of potassium are 4.34066 eV , 31.63 eV , 45.806 eV , respectively. The triple ionization ($t = 3$) reaction of K to K^{3+} , then, has a net enthalpy of reaction of 81.7766 eV , which is equivalent to $3 \cdot 27.2\text{ eV}$. Intense extreme ultraviolet (EUV) emission was observed from incandescently heated atomic hydrogen and the atomized potassium catalyst that generated an anomalous plasma at low temperatures (e.g. $\approx 10^3\text{ K}$) and an extraordinary low field strength of about $1\text{-}2\text{ V/cm}$. No emission was observed with potassium or hydrogen alone or when sodium replaced potassium with hydrogen. Emission was observed from K^{3+} that confirmed the resonant nonradiative energy transfer of $3 \cdot 27.2\text{ eV}$ from atomic hydrogen to atomic potassium. The catalysis product, a lower-energy hydrogen atom, was predicted to be a highly reactive intermediate which further reacts to form a novel hydride ion. The predicted hydride ion of hydrogen catalysis by atomic potassium is the hydride ion $H^- (1/4)$. This ion was observed spectroscopically at 110 nm corresponding to its predicted binding energy of 11.2 eV .

27. R. Mills, "BlackLight Power Technology-A New Clean Hydrogen Energy Source with the Potential for Direct Conversion to Electricity", Proceedings of the National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001), pp. 671-697.

BlackLight Power, Inc. (the Company), a Delaware corporation based in its 53,000 sq. ft. headquarters in Cranbury, New Jersey, believes it has developed a new hydrogen chemical process that generates power, plasma (a hot ionized glowing gas), and a vast class of new

compositions of matter. Specifically, the Company has designed and tested a new proprietary energy-producing chemical process. The Company has developed high-power density, high-temperature, hydrogen gas cells that produce intense light, power orders of magnitude greater than that of the combustion of hydrogen at high temperatures, and power densities equal to those of many electric power plants. The Company is focusing on cells for generating light and plasma for lighting applications and direct conversion to electricity, respectively.

The cells generate energy through a chemical process (BlackLight Process) which the Company believes causes the electrons of hydrogen atoms to drop to lower orbits thus releasing energy in excess of the energy required to start the process. The lower-energy atomic hydrogen product of the BlackLight Process reacts with an electron to form a hydride ion which further reacts with elements other than hydrogen to form novel compounds called hydrino hydride compounds (HHCs) which are proprietary to the Company. The Company is developing the vast class of proprietary chemical compounds formed via the BlackLight Process. Its technology has far-reaching applications in many industries.

The power may be in the form of a plasma, a hot ionized glowing gas. The plasma may be converted directly to electricity with high efficiency, thus, avoiding a heat engine such as a turbine. The Company is working on direct plasma to electricity conversion. The device may be linearly scaleable from the size of hand held units to large units which could replace large turbines.

There are many advantages of the technology. The energy balance permits the use of electrolysis of water to split water into its elemental constituents of hydrogen and oxygen as the source of hydrogen fuel using a small fraction of the output electricity. Additionally, pollution produced by fossil and nuclear fuels should be eliminated since no green house gases, air pollutants, or hazardous wastes are produced. As no fossil fuels are required, the projected commercial operating costs are much less than that of any known competing energy source.

The Company's process may start with water as the hydrogen source and convert it to HHCs; whereas, fuel cells typically require a hydrocarbon fuel and an expensive reformer to convert hydrocarbons to hydrogen and carbon dioxide. The Company's plasma to electric conversion technology with no reformer, no fuel cost, creation of a valuable chemical by-product rather than pollutants or green house gases such as carbon dioxide, and significantly lower

capital costs and operating and maintenance (O&M) costs are anticipated to result in household units that are competitive with central power and significantly superior to competing microdistributed power technologies such as fuel cells.

28. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By 

Dr. Randell L. Mills

Date: 1/21/02